Original Articles

SPINAL CORD INJURY: AN EPIDEMIOLOGIC PERSPECTIVE¹

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Abstract. This study examines, from an epidemiologic perspective, a series of 359 consecutive admissions to a Model Regional Spinal Cord Injury Center located in the south-eastern United States. An extensive data set which captures medical, demographic, social and psychological information, on each patient, has been statistically analysed. The appropriateness and utility of epidemiologic methodology applied to the phenomena of spinal cord injury is demonstrated and the findings resulting from the analyses are discussed.

Key words: Spinal cord injury; Epidemiology; Psycho-social characteristics.

Introduction

HIPPOCRATES first described spinal cord injury and its associated sequela in his commentary entitled *On the Articulations* (Hippocrates, in Adams 1886a). In another work (Hippocrates, in Adams, 1886b), he also addressed the investigational merit of epidemiologic methodology when he stated: 'Whoever wishes to investigate medicine properly should consider the greater particular nature of disease and what effects each produces . . . so he will not be in doubt as to treatment . . . or commit mistakes, as is likely to be the case provided one has not considered these matters.'

Nevertheless, the scientific community did not appreciate that accidents such as traumatic spinal cord injuries and their resultant physical damage conform to the same biological laws as do diseases and regularly exhibit comparable behaviours until Gordon (Gordon, 1949) suggested that injuries are appropriately studied by the extension and application of epidemiologic principles. Furthermore the outlook for a cord injured patient was so bleak that the possibility for long-term follow-up was considered extremely remote.

The short- and long-term prognosis for the cord injured patient did not improve until the Second World War when the British pioneered far-reaching medical achievements in the care of these patients. The efforts and achievements of Guttman and others have markedly increased life expectancy of the spinal cord injury patient and have enabled practitioners to consider sequelae of cord injuries much as their predecessors considered the progression of infectious and non-chronic disorders. We have chosen, therefore, to follow Gordon's footsteps and to utilise an epidemiologic approach for this analysis of spinal cord injury.

Materials and Methods

Since 1973 an extensive data set has been collected on a series of 359 patients admitted to the Model Regional Spinal Cord Injury Center at the University of

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Alabama in Birmingham as part of an on-going federally sponsored programme. The Model Regional Spinal Cord Injury Center's approach to patient care is centred around a multi-disciplinary team consisting of several medical specialists headed by the attending physiatrist, and personnel from the disciplines of rehabilitation nursing, physical therapy, occupational therapy, psychology and social service.

In this report we have examined and analysed the data via the technique of observational epidemiology which incorporates standard statistical procedures and practices. Specifically, we have considered a number of social, psychological and culturally related parameters in addition to medical descriptors.

Observations

Age

In this series, 196 lesions (54 percent) occurred among persons between 15-29 years of age, with 81 per cent occurring in the 0-44 years age group (Table I). Similar findings have been reported (Key and Retief, 1970; Guttmann, 1976). More lesions occurred among the 60+ year subgroup than among the 0-14 year subgroup. A variety of factors, such as fragility of the body skeleton, markedly different physical activities, etc., may account, at least in part, for the differences.

Clearly, there is not uniform distribution of incidence across the study population subgroups. The most common aetiologies, discussed in a subsequent section, explain, in great part, the reason for this finding. Our data are consistent with National Safety Council (NSC) data which have long reflected the preponderance of accidental deaths and injury occurring in the 0-44 year and especially in the 15-29 year age group.

Sex

In this series we observed 359 lesions distributed among 291 males and 68 females (Table I). This four to one male to female ratio is consistent with findings reported by other workers (Key and Retief, 1970; Wilcox *et al.*, 1970).

TABLE I

Incidence rates of spinal cord lesions by age group, sex, and race (incidence rates are expressed per 10⁶ persons at risk)

Age range	White				Non-white				Total		P*	
	Male		Female		Male		Female		N	Rate	Male	Female
	N	Rate	N	Rate	N	Rate	N	Rate				
0-14	8	6.3	2	1.7	1	1.7	2	3.5	13	3.6	<0.05	<0.5
15-29	133	122.8	18	16.4	36	100.4	9	22.4	196	66.7	<0.5	<0.5
30-44	41	52.5	14	17.0	14	76.1	11	44.7	80	39.3	<0.01	<0.005
45-59	25	34.9	5	6.5	16	83.1	3	12.6	49	25.6	<0.005	<0.1
60+	8	14.9	4	5.6	9	47.7	0	0.0	21	12.4	<0.005	<0.05
All ages	215	49.1	43	9.3	76	50.5	25	14.6	359	29.4	<0.9	<0.5

* Columns headed by 'P' give significant levels for χ^2 tests (df = 1) comparing white and non-white incidence rates of males and females.

When examined in light of our morbidity data, spinal cord injury is reconfirmed as a condition most commonly associated with the male, despite the fact there are slightly more females at risk in our geographic catchment area.

Race

Although the racial distribution among 359 spinal cord injury victims in this series was slightly more than 2 : 1, white versus non-white (Table I), the raw numbers may be misleading. Utilising 1970 Alabama population statistics, the race-specific incidence rate (per million persons at risk) for spinal cord injury was slightly higher for non-whites than for whites despite the fact more lesions occurred among whites. This difference was not statistically significant, however.

This is consistent with the higher accidental death rate observed among non-white citizens, although the calculated differences are not dramatic. Still, this is an estimated mean incidence figure pertaining to morbidity and the NSC figure refers to mortality.

Age-Sex Specificity

Table I presents our data from an age-sex specific standpoint. There were approximately six times as many lesions observed among males between 15 and 29 years as among females. There were more than twice the number of lesions observed among males than females in the 30-44 year age group. In no age group did the number of lesions occurring among females exceed the number of lesions occurring among males.

Age-Race Specificity

Table I depicts the age-race specificity of the 359 lesions. The data reveal that occurrence of cord lesions among whites exceeded occurrence of lesions among non-whites in every age group. Despite the absence of a statistically significant difference in incidence rates between whites and non-whites in the 'all ages' category among either males or females, many age specific differences in incidence rates between whites and non-whites were observed in both sexes. Among the males, there was a statistically significant difference between whites and non-whites in all age groups except the 15-29 age group as shown in Table I. Statistically significant differences were observed, also, among white and non-white females in the 30-44 and the 60+ age groups.

Overall Incidence

While it is difficult to estimate accurately the true incidence of traumatic spinal cord injury, other workers (Thorsen, 1973; Kraus, 1975; Kurtzke, 1975) have estimated the incidence rates to vary between 22 and 30 per million. Our findings (29.4 per million) are in agreement with these estimates (Table I).

Level of Lesion

The level of lesions for patients in this series are given in Table II which reveals a preponderance of lesions occurring in the cervical and thoracic segments. The number of lesions in the former exceeds the latter despite the fact there are more thoracic levels at which injury may occur. Indeed in this series, cervical injury occurred more frequently than did injury at any other level. It has long been a clinical impression that lesions of C5 and C6 are seen most often but these data do not confirm this impression. Of 169 cervical lesions 51 (30 percent)

were at C4, 52 (31 percent) were at C5; and 42 (25 percent) were at C6. Another recent study of cervical lesions showed 67 percent were at C4, 20 percent were at C5, and only 8 percent were at C6 (Shrosbree, 1977).

Only eight (2 percent) of the patients admitted sustained lesions at C1, C2 or C3. This is not surprising because it is generally accepted that (C4 is the lowest level at which a lesion may occur which will not require artificial respiratory support and lesions at these higher levels usually result in early death of the victim due to paralysis of respiratory musculature. Further, it is frequently observed that patients sustaining fractures to the body of C1-C3 do not experience neurological deficit and are not, therefore, referred to the rehabilitation setting.

In this series there were 160 thoracic lesions distributed unevenly among the 12 susceptible levels. Lesions at T12 were most numerous (29) followed by 19 lesions at T4. Lesions at the levels of T4, T5, T6, T10, T11 and T12 accounted for 70 percent of the 160 thoracic lesions. Only when considering the 37 lesions recorded at T12 and L1 was a number observed which approached the number of lesions occurring at either C4, C5 or C6. Twenty-five lesions (6 percent) occurred

TABLE II

Levels of lesion by specific neurological level and vertebral segment ($n = 356$)

Neurologic Level	Vertebral Segment			
	Cervical	Thoracic	Lumbar	Sacral
1	1	2	8	1
2	3	7	4	1
3	4	12	8	-
4	51	19	3	-
5	52	18	2	-
6	42	15		
7	14	9		
8	2	6		
9		11		
10		18		
11		14		
12		29		
Total Lesions	169	160	25	2
by Segment*				

*Three cases were intact at admission to rehabilitation center, original level is unknown.

at the lumbar level. Only two (0.5 percent) lesions were observed at the sacral level.

Extent of Lesion

Extent of the spinal cord lesion is an important determinant of functional recovery and eventual rehabilitation outcome. Victims of incomplete lesions, all other things equal, may anticipate better rehabilitation results in a shorter time with a somewhat lower associated cost (Stover *et al.*, 1977). Lesions are categorised herein as complete or incomplete.

In this series of patients, 201 lesions (56 percent) were diagnosed as complete at time of admission, with 155 being diagnosed as incomplete (Table III). These data do not relate the number of lesions which were initially complete and became incomplete.

Level and extent of Lesion

Table III relates extent of lesion to level of lesion. It is clear they are not independent ($\chi^2 = 44.87$, $df = 2$, $p < 0.001$). Since high complete cervical lesions seldom survive and complete lesions of the cauda equina region are uncommon, this result is expected.

It may be observed that the number of complete cervical lesions almost equalled the number of incomplete cervical lesions and the numeric difference was not statistically significant. There were nearly three times as many complete thoracic lesions as incomplete thoracic lesions, a significant difference ($\chi^2 = 38.03$, $df = 1$, $p < 0.005$). The predominance of complete thoracic lesions in other series has been interpreted by some workers as indicative of a need for improved methods of stabilisation of this anatomic region at the site of trauma and perhaps during early acute management. Yet, we believe that greater forces are required to cause thoracic lesions than cervical lesions. It seems reasonable, therefore, that greater forces will influence the probability of more extensive physical damage thus increasing the likelihood of a complete lesion.

A similar but reverse phenomenon is noted among the lumbar lesions from this series of patients; there were four times as many incomplete lesions as complete lesions in this segment.

TABLE III
Extent of lesion at each level of injury

Level of lesion	Extent of lesion				Total N
	Complete		Incomplete		
	N	%	N	%	
Cervical	77	46	92	54	169
Thoracic	119	74	41	26	160
Lumbo-sacral	5	19	22	81	27
Total	201	56	155	44	356

Note: Three cases were intact at admission to rehabilitation center, original level is unknown.

The number of sacral lesions was too small for any meaningful analysis to be attempted.

Aetiology

The aetiology of spinal cord injury is diverse. The categories in Table IV were chosen as the presumed major causes of spinal cord injury in this series.

Motor Vehicle Accidents

Past studies have shown that more spinal cord injuries result from motor vehicle accidents than any other cause (Wilcox *et al.*, 1970; Guttmann, 1976). In our series, 152 (42 percent) of the 359 lesions in this study were caused by motor vehicle accidents. This includes eight pedestrian injuries, 35 injuries to motorcycle riders, and 109 injuries to occupants of automobiles, trucks, or other motor vehicles. Of the 35 motorcycle riders, 32 were operators, and three were passengers. Of the 109 motor vehicle occupants, 67 were operators and 42 were passengers (Table IV).

Water Sports

Only 25 (7 percent) lesions were caused by water sports (Table IV). Other studies have shown higher proportions of injuries caused by water sports accidents (Guttmann, 1976).

Acts of Violence

Seventy-six (21 percent) of the 359 lesions were caused by acts of violence. Seventy-four (97 percent) of these were due to gunshot wounds and two (3 percent) were due to stab wounds (Table IV).

Other and Unknown

One-hundred and six (29.5 percent) lesions of this series are aetiologically

TABLE IV
Number of complete and incomplete injuries for each aetiology

Aetiology	Extent of lesion		Total	% of total
	Complete	Incomplete		
Motor vehicle driver	38	29	67	18.66
Motor vehicle passenger	20	22	42	11.70
Motorcycle driver	24	8	32	8.91
Motorcycle passenger	1	2	3	0.84
Pedestrian	4	4	8	2.23
Water sports	13	12	25	6.96
Gunshot wound	49	25	74	20.61
Stabbing	—	2	2	0.56
Other	45	53	98	27.30
Unknown	7	1	8	2.23
Total	201	158	359	100.00

classified in the 'other' and 'unknown' categories. These include lesions due to falls, falling objects, and other causes not classified above (Table IV).

The choice of categories was not as useful as originally hoped. Together, stabbings and injuries sustained by motorcycle passengers and pedestrians account for only 13 of the 359 injuries (3 percent), while other and unknown causes account for 106 (29.5 percent). The eight injuries due to unknown causes were industrial accidents, but were not otherwise categorised for data collection purposes in the early months of the study. These have been analysed further, and it is found that the majority were caused by falls, or by the victims being struck by falling objects. The data base contains no information to distinguish 'accidental' lesions from 'non-accidental' lesions in any category of aetiology.

Additionally, Table IV reflects the extent of lesion related to aetiology. Lesions due to gunshot wounds resulted in an almost two to one ratio of complete to incomplete lesions while motorcycle drivers experienced a three to one ratio of complete to incomplete lesions. Both these differences of complete to incomplete lesions were statistically significant (Gunshot, $\chi^2 = 7.78$, $df = 1$, $p < 0.01$; Motorcycle drivers, $\chi^2 = 8.00$, $df = 1$, $p < 0.005$). An excess of complete lesions which occurred among motor vehicle drivers was not statistically significant ($\chi^2 = 1.21$, $df = 1$, $p < 0.5$). No other statistical dependences were evident.

Month (of Trauma)

Examinations of lesion, in this series, by month of occurrence, suggests a clustering about the summer months (Fig. 1). There is a noticeable increase in the number of lesions which begins in April, and tapers off in October, although there is not absolute uniformity.

Causation appears to be a factor influencing monthly, geographic, and seasonal cyclicity (Fine *et al.*, 1976). It is known that water sports (including skiing and diving) constitute a major source of spinal cord injury. These activities are traditionally engaged in during warmer months, and probably account for a portion of the second and third quarter increase.

Psychological Data

Objective testing instruments administered in the evaluation were the Wechsler Adult Intelligence Scale (WAIS), or the Wechsler Intelligence Scale for Children (WISC) where it applied, the Mathematics and Reading Comprehension Tests of the Peabody Individual Achievement Test (PIAT), and the Minnesota Multiphasic Personality Inventory (MMPI). Kincannon's Mini-Mult Form of the Minnesota Multiphasic Personality Inventory was substituted for the regular form of the MMPI; it was developed by Hathaway and McKinley for use with quadriplegic patients, and patients whose reading comprehension level was considerably below average. These particular psychological tests were chosen because they yield objective scores which can be recorded in a data bank, and therefore are easily retrievable, by computer, for research purposes. These tests are well standardised, well researched, and widely used throughout the United States for such purposes.

At present, IQ data have been acquired on a subset of 311 patients in this series (Table V).

The Performance Scales of the WAIS and WISC were not administered to the tetraplegic patients because of their inability to produce valid results on tests which assess motor performance. In these cases the verbal IQ was used as

an estimate for the tables in this and the following sections. There was no statistically significant difference between the means and standard deviations of the total IQ and the verbal IQ.

FIG. 1—Number of lesions by month of occurrence.

TABLE V
IQ distribution of spinal cord injury victims

IQ range	Number	% of total	Expected statistical dispersion (%)
≤ 69	26	8.4	2.2
70-79	53	17.0	6.7
80-89	53	17.0	16.1
90-109	124	39.9	50.0
110-119	38	12.2	16.1
120-129	13	4.2	6.7
130+	4	1.3	2.2
Total	311	100.0	100.0

The mean IQ for 311 patients was determined to be 92.6 (s.d. = 17.1). Standard IQ distribution has a mean of 100 (s.d. = 15) (Metarazzo, 1972). The IQ score correlates well with socio-economic status and educational attainment (school years completed), both of which are below average in the south and south-eastern United States (Bureau of the Census, 1975). Also, a high proportion of the patients in this series are Black, and the national standard mean IQ of Blacks is 11 points lower than that of Whites (Metarazzo, 1972) (Fig. 2).

Marital Status

In this series, there were roughly equal numbers of single (never married) and married patients (Table VI). Similar findings have been reported (Deyoe, 1972; Guttmann, 1976). Only 37 (11 percent) reported having a legally terminated marital status (divorced or widowed). It is important to note these data were collected at time of initial admission to the Spinal Cord Injury Center, and often change at follow-up. Guttmann's study, cited above, found that among single patients prior to admission, approximately 39 percent married after admission, while approximately 5 percent of those patients who were married prior to admission, and approximately 7 percent of those patients who married after admission later divorced. Deyoe found a post-injury separation rate among spinal cord injured patients of one in eight, which was below the United States national average. He also reported that among patients in his series, income had little effect on marital status.

Employment Status

An ever-present concern of rehabilitation workers is the eventual re-entry of the physically disabled into the work force.

FIG. 2—Standard IQ curve for patients in SCI project (N = 311).

It has been demonstrated, previously, that many cord victims are quite young (Key and Retief, 1970), and have lower than average scholastic abilities and preparation (Stover *et al.*, 1977). In general, these limitations may negatively influence their ability to achieve meaningful vocational return even after an arduous and lengthy rehabilitation program.

We considered premorbid employment status to be a significant parameter against which to gauge eventual vocational success or failure (Table VII). It may be observed that the vast majority (88 percent) of the spinal cord injury victims from this series reported themselves 'working' at the time of injury. This figure includes homemakers, students, sheltered workshop participants, etc., but is acceptable for this purpose because it is a categorical classification distinctly different from 'not working'.

While we have not yet evaluated postmorbid employment status, in a series of spinal cord injured patients reported by Guttmann, 85.4 percent of those patients available for employment were employed at least part-time or in home occupations, and most were employed full-time (Guttmann, 1976).

TABLE VI
Marital status at time of admission

Marital status	Number	% of total
Single	154	43
Married	145	40
Divorced	31	9
Separated	15	4
Widowed	6	2
Common-law	6	2
Other	1	0
Unkown	1	0
Total	359	100

TABLE VII
Employment status of patients at the time of injury

Employment category	Number	Percentage
Working	208	58
Self-employed	14	4
Housewife	18	5
On job training	14	4
Sheltered workshop	10	3
Retired	10	3
Student	52	14
Not working	27	8
Other	3	1
Unknown	3	1

TABLE VIII
Family and patient income ranges

Income range	No. of families	Percentage	No. of patients	Percentage
\$0- 4 999	211	58.77	184	51.25
\$5 000- 9 999	67	18.66	108	30.08
\$10 000-14 999	44	12.26	35	9.75
\$15 000-19 999	11	3.06	17	4.74
\$20 000-24 999	9	2.51	3	.84
\$25 000+	7	1.95	3	.84
Unknown	10	2.79	9	2.50
Total	359	100.00	359	100.00

Income: Family and Personal

Income is an important epidemiologic and vocational consideration. It serves as a definitive parameter for establishing socio-economic and epidemiologic study groupings, and may influence many immediate and long-term rehabilitation opportunities and pursuits.

The Social Service Section of the Spinal Cord Injury Center routinely acquires personal and family income data. These findings are given in Table VIII. It may be observed, from the table, that 77 per cent of all family income, and 81 per cent of all personal (victim) income was less than \$10 000 at the time of injury. The personal income is less significant when one considers the average age and the average educational level of most victims. In our series, 59 per cent of the families earned less than \$5 000, while the 'poverty' level cut-off for non-farm families of four members, as defined by the United States Department of Commerce, is \$5 500 (Bureau of the Census, 1975).

Discussion

In this study, we have examined a series of 359 spinal cord injury patients admitted to a specialised centre during a 42.5 month period. The investigational approach was that of descriptive or observational epidemiology. Based upon these observations, several conclusions are apparent, and numerous impressions, some of long standing, continue to be supported by data.

The incidence of spinal cord injury in our population at risk is consistent with incidence statistics reported elsewhere in the literature. Additionally, the age-sex specificity has been reconfirmed and demonstrated statistically.

The concept of causation or aetiology was examined with comparisons being made between this series and others described elsewhere. The remarkable similarity in aetiology confirms the inherent risk of spinal cord trauma associated with motor-vehicle occupancy, gunshot wounds, and diving or water-sports.

Past studies have reported a higher incidence of thoracic lesions than cervical lesions, yet the trend in recent years has suggested a reversal of this pattern. It is possible the cervical vertebrae are more vulnerable than other vertebrae due

to their extreme mobility, and their role in balancing the cranium on the atlanto-occipital joint at one end while attaching to the rigid thoracic cage and vertebrae at the other. The ease with which these bony structures rotate, flex, and extend may indicate comparatively poor mechanical stability (Hardy and Rossier, 1975). Nonetheless, it is our impression the rather interesting shift reflected in the increasing incidence of quadriplegia in 'level-of-lesion' data is not due to a truly higher incidence of cervical injuries, but more correctly the result of vastly improved handling and management techniques with subsequent survival of patients who previously may have died at the accident scene, during emergency evacuation or shortly after acute care admission.

Simply, it is not our impression more patients are breaking their necks than their backs today. But among those who do, the probability of short-term survival is markedly enhanced, thus providing for their eventual inclusion in the statistical base.

In an attempt to understand, more fully, the personal characteristics of the victim, several psycho-social parameters were scrutinised. Included in these variables were functional intelligence quotient, patient and family income, employment history, and marital status. The implications and potential ramifications of the possible roles of these variables in accident-related behaviour and eventual rehabilitation outcome must be considered. For example, the patient's vocational rehabilitation potential may be seriously compromised due to intellectual limitations and educational experience. The inability of the patient and family to cope with a catastrophic medical condition requiring reasonably sophisticated day-to-day maintenance practices may predispose the patient to development of frequent medical complications such as urinary tract infection, decubitus ulceration, general deterioration of health-status, etc. Psycho-sexual difficulties frequently arise, and are compounded for victims with limited pre-morbid sexual experience. Finally, the economic impact of spinal cord injury on a family unit can be devastating. Therefore, the long-term prospects for successful adjustment must be judged not only in terms of excellent medical care and rehabilitation services, but also in terms of the type of person most often injured.

Rehabilitation professionals and allied health workers are well advised to consider the patient as a total entity because the numerous potential problems typically associated with spinal cord injury, coupled with the characteristics of most victims, may significantly influence the eventual outcome of each individual case.

It seems fair to conclude that many if not most of those who sustain spinal cord injury may be least able to deal with it (Gunther, 1969).

Summary and Conclusions

A series of 359 spinal cord injury victims was studied, retrospectively, to determine both the general and specific nature of their lesions. Additionally, numerous psycho-social parameters were examined to determine whether characteristics of this series differed from those reported by other workers.

Our findings indicated adherence to certain previously identified trends such as age-sex specificity and general aetiology. However, our data as well as those of Shrosbree (1977) suggest that lesions of C5 and C6 may not be as predominant as held previously. Nonetheless, cervical lesions occurred more frequently than did lesions at other levels thus confirming our clinical impression that tetraplegia is being seen more frequently today than in the past.

Assessment of select psycho-social characteristics of patients in this series substantiated findings reported by previous workers. However, a surprisingly high proportion of our patients indicated pre-injury employment or similar full-time endeavours. This seemed to contradict our general impression that many spinal cord injury victims were not involved in gainful pre-morbid activity. Also, an inordinately high number of patients in this series were from families whose income was well below the poverty level set by the federal government. The possible implications of this observation are dualistic in nature: (1) persons from certain socio-economic strata may manifest behavioural peculiarities predisposing them to involvement in potentially dangerous situations, and (2) society will have to continue to bear substantial costs associated with the acute, rehabilitation and long-term care required by spinal cord injury victims who are without the financial wherewithal to secure necessary health care services.

Our findings indicate the necessity of eliciting and considering the multiple and diverse characteristics of the spinal cord injury patient, as an aid to development of a suitable care plan and the establishment of realistic rehabilitation goals.

RÉSUMÉ

Cette étude recherche, d'un point de vue épidémiologique, une série de 359 admissions consécutives dans un Centre Régional modèle de Traumatisés de la moëlle épinière, situé aux Etats-Unis du sud-est.

On a analysé statistiquement des données étendues qui montrent, pour chaque malade, les renseignements médicaux, démographiques, sociaux, et psychologiques.

On démontre l'à-propos et l'utilité d'une méthodologie épidémiologique au sujet du phénomène des traumatisés de la moëlle épinière et l'on discute les résultats des analyses.

ZUSAMMENFASSUNG

Die vorliegende Studie untersucht aus epidemiologischer Sicht eine Serie von 359 aufeinanderfolgenden Aufnahmen in ein regionales Modellzentrum fuer Rueckenmarks-verletzte im Suedosten der Vereinigten Staaten.

Es wurde ein umfassendes Datenmaterial, das medizinische, demographische, soziale und psychologische Befunde eines jeden Patienten erfasst, statistisch untersucht.

Die Studie macht die Bedeutung und Anwendbarkeit von epidemiologischer Datenerfassung zur Beschreibung des Formenbildes 'Rueckenmarksverletzung' deutlich. Die aus der Analyse resultierenden Ergebnisse werden diskutiert.

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